Lesson 6: EPA PAGs – EPA PAGs – Implementation Guidance

Lesson Overview

As you learned in Lesson 1, during a nuclear incident when the source of exposure to the public is not under control, the public usually can be protected only by some form of intervention that will disrupt normal living. Such an intervention is termed a protective action. This lesson covers the guidelines included in the EPA PAG Manual.

Upon completion of this lesson, you will be able to:

- Explain the purpose of protective action guides (PAGs).
- Describe the importance of incident phases in planning for emergency response.
- Identify protective actions for the early and intermediate phases of a radiological incident.

Remember you can access the glossary in one of two ways throughout this course. You can select the glossary button in the top right hand corner of each main content screen. In addition, on content screens you can select underlined words to access their definitions in the online glossary. Selecting an underlined word will take you directly to its definition in the glossary.

This lesson should take approximately **30 minutes** to complete.

EPA Protective Action Guides

A Protective Action Guide (PAG) is a decision level for public officials during a nuclear incident. More specifically, it is the projected radiation dose to a standard individual, or other defined individual, from an unplanned release of radioactive material at which a specific protective action to reduce or avoid that dose is warranted. Projected radiation dose is the dose estimated to be received in a specified time in the absence of protective actions.

The EPA PAGs apply to all nuclear incidents or accidents except nuclear war. Nuclear incident or accident sites include:

- Nuclear power plants
- Other nuclear facilities (fuel cycle, defense and research, producers or users or radioisotopes)
- Nuclear weapons (nondetonation)
- Transportation
- Satellites (launch or reentry)
- Radiological dispersion devices (RDD)
- Improvised nuclear devices (IND)

A nuclear incident is defined as an event or a series of events, either deliberate or accidental, leading to a release, or potential release, into the environment of radioactive material in sufficient quantity to warrant consideration of protective actions.

Applicability of EPA PAGs

PAGs apply equally to almost all population groups. Exceptions apply in high-risk situations and for some special populations. Examples of these exceptions include:

- Presence of severe weather
- Competing disasters, such as a chemical spill
- Institutionalized persons who are not readily mobile (critical care patients, inmates, etc.)
- Local physical factors that impede evacuation

Nuclear Incident Phases

It is generally accepted that all nuclear incident sequences pass through three common phases; within each phase, different considerations apply to most protective actions. These common phases include:

- **Early** - At the beginning of a nuclear incident involving a large release of radioactive material to the atmosphere, when immediate decisions for effective use of protective actions are required. This phase is also called plume or emergency phase. Doses may accrue in this phase from airborne and deposited radioactive material as well as from inhalation of radionuclides.
- **Intermediate** - Beginning after the source and releases have been brought under control and reliable environmental measurements are available. Doses may accrue in this phase from deposited, resuspended, and ingested radioactive material.
- **Late**- Beginning when actions are commenced to reduce radiation levels in the environment to acceptable levels to allow inhabitants unrestricted use of the area. This phase is also referred to as the recovery phase. Currently, there are no EPA PAGs specific to the late phase.

It is important to note that PAGs have been developed for the first two phases of a nuclear accident: early and intermediate.

Now that you've learned about the common phases of nuclear incidents, let’s examine how PAGs are designed to be used for planning purposes.

Planning (1 of 2)

PAGs are designed to be used for planning purposes, for example, to develop radiological emergency response plans and to exercise those plans. They provide guidance for response decisions and should not be regarded as dose limits.

The phase sequence described on the previous screen is most useful for planning. Different types of protective actions are required in each of the phases. The PAG for each phase has been constructed independent of the PAG for the other phases. For the purpose of working with the PAGs, any dose received during the early phase is not subtracted from a projected dose during the intermediate phase.

Another way of thinking of this would be that doses are not additive from phase to phase. PAG doses are based on avoidable dose and doses which have already been received are not included in subsequent decisions.

Planning (2 of 2)

Conditions and characteristics that are unique to each phase can affect the planning during an incident. Select the links to learn more about planning considerations during each phase.

- **During early phase** –
  - The release is still ongoing
  - Evacuation may be necessary because of potential exposure to external radiation from immersion in the plume
  - Potential exposure pathways are cloudshine, groundshine, and immersion
- **During intermediate phase** –
  - There is no chance of further release
  - The plume has dissipated
  - Environmental data collection activities should have begun
  - Food and water controls may have been instituted
  - Resuspension of radioactive materials and deposited radionuclides may require relocation and decontamination of surfaces
- **During late phase –**
  - Decontamination down to an established exposure rate or concentration may be necessary before an area can be reused

PAGs as Decision Levels

PAGs are decision levels for public officials. They are used to determine actions that will minimize risk from an event that is occurring or has already occurred.

The decision to advise members of the public to take an action to protect themselves from radiation from a nuclear incident involves a complex judgment in which the risk avoided by the protective action must be weighed in the context of the risks involved in taking the action.

Furthermore, the decision may have to be made under emergency conditions, with little or no detailed information available. Therefore, considerable planning is necessary to reduce to a manageable level the complexity of decisions required to effectively protect the public at the time of an incident.

Mandatory for Planning

Effective planning for nuclear incidents includes developing radiological emergency response plans. PAGs provide guidance for response decisions and should not be regarded as dose limits. Because conditions during a real incident cannot be anticipated when guidelines are developed during planning, professional judgment will be required in applying response plans to actual incidents.

The incident phases are independent from each other; however, they may overlap in terms of the potential exposure pathways involved and the protected actions required.

Resources used in the early phase may continue to be used in the intermediate phase. Dose limits for workers, however, are different for the first two phases. For the purposes of PAGs, doses accrued in the early phase are considered independently of those accrued in the intermediate.

PAG Supplemental Radiation Protection

The main contributors to radiation protection at fixed facilities are:

- Site selection
- Plant design
- Quality assurance in plant construction
- Engineered safety systems
- Competence of staff in safe operation and maintenance

These measures can reduce both the probability and magnitude of potential consequences of an accident.

Risks and Rewards of PAGs

PAGs are designed to protect all individuals in the population. However, some protective measures themselves present a certain degree of risk, and some population groups are at different levels of risk from those protective measures. The risk from being exposed must exceed the risk of implementing the protective action recommended.

Next you will learn about the protective actions and how they apply to the phases of radiological incidents.

Protective Actions

Protective actions are activities conducted in response to an incident or potential incident to avoid or reduce radiation dose to members of the public. Protective actions are sometimes called protective measures.

Early phase protective actions - Evacuation and sheltering (supplemented by bathing and changes of clothing) are the principal protective actions for use during the early phase to protect the public from exposure to direct radiation and inhalation from an airborne plume. It may be appropriate to initiate protective actions for the milk supply, and if included in emergency plans, to issue KI to reduce thyroid dose.

Intermediate phase protective actions - There are two types of protective actions during the intermediate phase. Relocation and decontamination are the principal protective actions taken to protect the public from whole-body external exposure due to deposited material and from inhalation of any resuspended radioactive particulates during the intermediate and late phases. The second type of protective action encompasses restrictions on the consumption and use of contaminated food and water. These protective actions will be discussed in the Lesson 9. During the intermediate phase of an incident, a new set of PAGs is used to determine the need to relocate from an area where contamination levels would cause an individual's dose to exceed 2 rem TEDE in the first year following

the cessation of the release. Long-term goals include relocation of individuals if the second-year, or any subsequent year, TEDE dose would exceed 0.5 rem, and 50-year dose would exceed 5 rem TEDE.The PAG Manual states on page 4-4, "For situations where it is impractical to meet these objectives though decontamination, consideration should be given to relocation at a lower projected first year dose than that specified by the relocation PAG." In the intermediate phase, protective actions are based on environmental measurements.

Some protective actions are not addressed by assignment of a PAG (e.g., access control and ad hoc respiratory protection). Access control is instituted during the first two phases to prevent individuals from exposing themselves unnecessarily by entering an area affected by the radioactive material. Respiratory protection is usually applicable for supplementary protection in some circumstances, usually by emergency workers.

Precautionary Actions

Precautionary actions are not defined or discussed explicitly in the PAG Manual. However, in the FEMA REP Program Manual (June 2013), precautionary protective actions are defined as any preventive or emergency protective actions implemented without the verification of radionuclide measurements by field monitoring or laboratory analysis.

Evacuation

The EPA defines evacuation as the urgent removal of people to avoid or reduce high-level, acute exposure from a plume and/or deposited radioactive materials.

How is evacuation different from relocation?

- Evacuation is the primary protective action to prevent dose from the airborne plume.
- Relocation, which will be discussed later in this lesson, is used in the intermediate phase rather than in the early phase. Relocation is the removal or continued exclusion of people (households) from contaminated areas to avoid low-level, long-term chronic radiation exposure.

Evacuation: Basis for Decision

The decision to evacuate is based on:

- Plant conditions: whether the potential exists for doses to exceed PAGs beyond the site boundary.
- Projected dose: based on predicted, potential, or actual releases. Environmental measurements should be collected to verify whether the initial designated area for evacuation included all areas that exceeded the PAGs.

Evacuation: Considerations

The 1975 EPA study "Evacuation Risks—An Evaluation" concluded that:

- Evacuation provides complete protection from radiation if implemented before the plume arrives.
- Risks associated with automobile travel in contaminated areas are known.

- Risk of injury or death from automobile travel does not change during an evacuation.
- The risk from evacuation was considered in establishing the PAG.

Evacuation Summary

- Sheltering may be preferable to evacuation in some situations, but usually only if environmental constraints, such as competing disasters (e.g., debris after tornado has blocked roads), exist.
- People can be evacuated from affected areas with minimal risk.
- Neither panic nor hysteria is typically observed when evacuations of large areas are managed by public officials.
- Most evacuees use their own transportation and provide their own food and shelter.
- Advance planning and exercising are essential to identifying potential problems that may occur in an evacuation.

Sheltering

FEMA and the Nuclear Regulatory Commission (NRC) define sheltering-in-place as going inside, closing all doors, turning off heat and air conditioning systems and tuning radio or TV to an emergency station. The most protective areas in the home are a central area or the basement.

Sheltering effectiveness is significantly reduced if windows or doors are opened or large cracks are present. Risk of failure of sheltering is assumed to be high. Sheltering is usually not appropriate in areas where high doses are projected or where exposure might last longer than two complete air exchanges of the shelter.

Potassium Iodide (KI)

Another protective action that might be taken concurrent with or after an exposure event is the administration of potassium iodide (KI).

Administration of stable KI blocks inhaled radioiodine from accumulating in the thyroid gland. KI should not be used as an alternative to evacuation if evacuation prior to exposure is feasible.

You will learn more about KI dosage in Lesson 8.

Potassium Iodide (KI): Effectiveness

KI protects only the thyroid from inhaled or ingested radioiodine.

- KI is 95% effective in blocking thyroid absorption of radioiodine when taken one to two hours before or concurrently with exposure.
- KI is 50% effective when taken three to four hours after exposure.
- KI is minimally effective when taken 12 hours after exposure.
- KI is 50% effective when taken 30 to 50 hours before intake of radioiodine.

Potassium Iodide: Side Effects

The risk of incidence and the severity of side effects from KI are uncertain. However, the FDA has stated that the risk of thyroid nodules and cancer from 25 rem to the thyroid outweighs the risk of side effects from KI administration.

KI is contraindicated for persons with known allergies to iodine. Medical procedures for iodine allergy testing are available, and approval by medical officials for KI ingestion is advised for all persons before taking KI.

FEMA recommends distribution of KI to emergency workers and institutionalized persons and if the state approves, the public, for use during emergencies. You will learn more about the administration of KI in Lesson 8.

Relocation

Relocation is the removal or continued exclusion of people from contaminated areas to avoid chronic exposure to radiation leading to a dose exceeding the intermediate-phase relocation PAG of:

- 2 rem TEDE or 100 rem DE skin beta in the 1st year
- 0.5 rem TEDE 2nd or subsequent years

Individuals already evacuated may be converted to relocated status if their residence or place of employment is located in the area that exceeds the relocation PAG. Personnel not evacuated during the early phase may now require relocation.

Evacuees may return to areas not within the restricted zone (RZ). Those who must reenter the RZ for important duties must use radiation protection methods.

Relocation: Constraints

For relocation to be recommended, the following exposure rates must be calculated at 1 meter from the ground that equates to:

- 2 rem TEDE in the first year
- 0.5 rem TEDE in the second or subsequent years

Determination of areas to be restricted should be based on factors such as:

- The mix of radionuclides in deposited materials
- Calculated exposure rates versus the PAGs
- Field samples of vegetation and soil analysis

The boundary of the RZ must be established and all within that boundary are candidates for relocation. The easiest method entails using aircraft with sensitive radiation detection equipment capable of correcting the readings to one meter from the ground.

Access Control

The purpose of access control is to restrict access to the affected area. It supplements protection from sheltering, evacuation, and relocation. There is no PAG for access control.

The advantage of access control is that is provides a simple and effective way of reducing risk to people outside the affected area.

There are also constraints on access control. Effective communications and traffic control are required to implement access control effectively. Planning is necessary to ensure the presence of sufficient resources to adequately control the access. Access control may be a long-term undertaking.

Control of Surface Contamination

If aerosols or particulate materials are released during an incident, the resulting plume can be expected to deposit radioactive materials on the areas over which it passes. In extreme cases, individuals and equipment may be highly contaminated, and screening stations will be required for emergency monitoring and decontamination of individuals and for determining which individuals need medical evaluation. Equipment should be checked at this point and decontaminated as necessary to avoid the spread of contamination to other locations.

Once the RZ boundary has been established, in the intermediate phase, emergency personnel may reenter the RZ under controlled conditions in accordance with occupational dose limit criteria. Monitoring stations will be required at locations near the RZ boundary. Because of the potential high background radiation at these gross monitoring stations, significant amounts of contamination may be undetectable.

Additional monitoring stations may be needed at nearby low-background areas.

Decontamination (1 of 2)

Decontamination involves the removal of radioactive material from surfaces. Washing and changing clothing is recommended primarily to provide protection from beta radiation from radioiodines and particulate materials deposited on the skin or clothing. During the emergency, there is no need to control the runoff from personnel decontamination efforts. During the emergency phase, monitoring and decontamination efforts may take place a considerable distance from the affected area.

Urgent medical care should not be delayed for decontamination efforts or for time-consuming protection of attendants. Monitoring and decontamination also should not be allowed to delay evacuation from high- or potentially high-exposure-rate areas.

Select this link to access a table that describes the recommended surface contamination screening levels for emergency screening of persons and other surfaces at screening or monitoring stations in high background radiation areas.

Decontamination (2 of 2)

After the RZ is established, it may be necessary to move monitoring and decontamination facilities to locations near the boundary of the RZ.

Because background levels may be higher near the RZ, low levels of contamination may be undetectable. Individuals exiting the RZ found to be uncontaminated nevertheless should be advised to bathe and change clothes within the next 24 hours.

Lesson Summary

Let's summarize what you learned in this lesson:

- A protective action guide (PAG) is a projected dose at which actions to reduce or avoid that dose is warranted.
- Nuclear incidents generally pass through three common phases; early, intermediate, and late phases.
- Precautionary action is an action taken on the basis of the potential for a release of radioactive material.
- Evacuation, sheltering, and administration of potassium iodide are some of the protective actions that should be taken in the early phases of an incident.
- Relocation is a protective action that should be taken in the intermediate phase of an incident.